3.1.9. STRATOSPHERIC WATER VAPOR

In addition to the ongoing monthly water vapor profile measurements at Boulder, the program of winter soundings at SPO was augmented to give a better picture of the strong dehydration that develops in the Antarctic stratosphere.

As temperatures in the stratosphere drop dramatically in May, they become low enough (-80°C) to begin the process of Type I (nitric acid trihydrate) polar stratospheric cloud (PSC) formation. Temperatures do not reach the local water frost point (approximately -90°C), however, until June when Type II PSCs begin to form and dehydration proceeds rapidly. PSCs play a key role by processing chlorine in the winter stratosphere and by removing nitrogen in its chemically active forms. Figure 3.13 shows two stratospheric water vapor profiles obtained at SPO in 1993. In May there is no sign of dehydration with stratospheric mixing ratios gradually increasing from 3.5 ppmv at about 12 km to 5 ppmv at the top of the sounding at 27 km. In this region, frost-point temperatures are 7-10 degrees lower than the saturation temperature. By the end of June, a broad region from 15-25 km shows dehydration, and the entire region has saturated conditions. The relative maximum in mixing ratio just below 14 km is a result of ice crystal reevaporation where the falling crystals encounter somewhat warmer conditions.

Lidar profiles from the University of Rome lidar **(**Figure 3.14**)** show that by June 29 there is a broad region of PSCs that encompasses the dehydrated region below 20 km. Above 20 km, ice particles have probably already settled to somewhat lower altitudes. Even in the region near 16 km, where some crystals have evaporated, there are still sufficient numbers to keep this region near saturation.

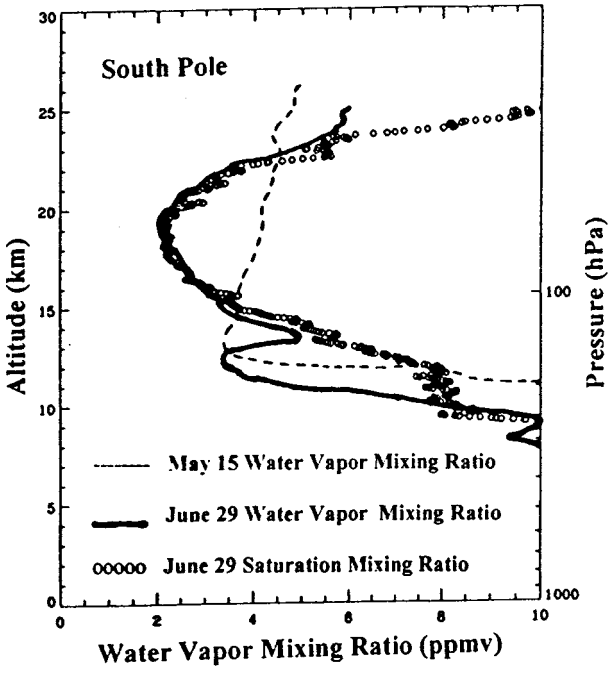

Fig. 3.13. Stratospheric water vapor mixing ratio profiles at SPO on May 15, 1993, and June 29, 1993.

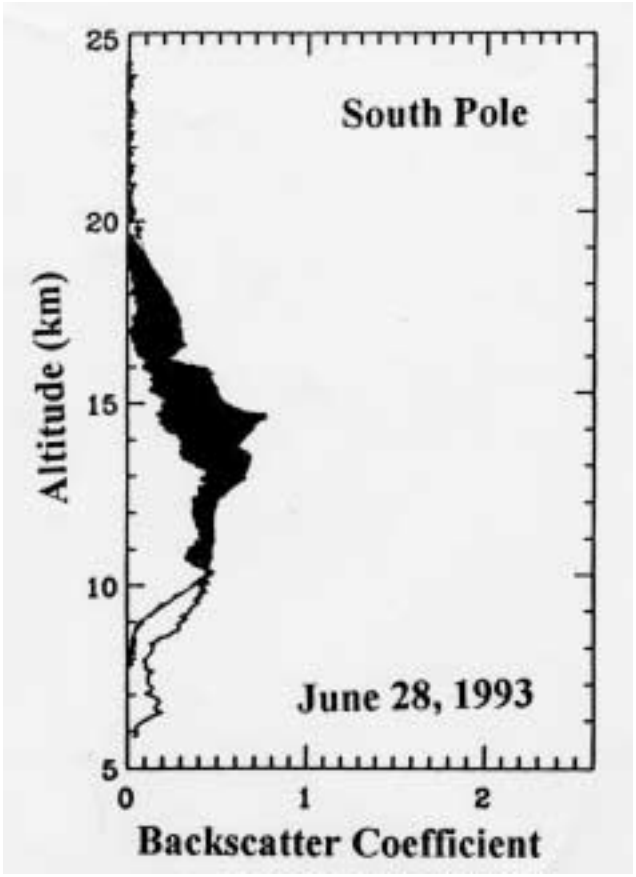

Fig. 3.14. Two lidar profiles of the non-Rayleigh backscatter observed over SPO during 1993. The inner line is the backscatter resulting primarily from the presence of Mt. Pinatubo aerosol and is from a profile in May before PSCs formed. The shaded area shows the enhanced signal due to the presence of PSCs on June 28, 1993.

Data from McMurdo, on the coast of Antarctica, on September 4 show the extent of dehydration achieved by the end of the winter with mixing ratios below 2 ppmv over an altitude range of nearly 10 km. The McMurdo data also show that the dehydration is present throughout the area within the polar vortex not just in the interior of Antarctica. By summer, though air temperatures have warmed dramatically, there is still a large dehydrated region giving strong evidence that the polar vortex is still intact below 20 km. If air from outside the vortex were mixing rapidly into the interior of Antarctica, the stratosphere would be quickly rehydrated since water vapor could no longer be removed.

During the winter above 25 km, the stratosphere stays rather moist with mixing ratios in the 5-6 ppmv range. This probably reflects the descent within the vortex as the air continues to cool and sink.